

FORM P 1390
(REV. 1 2000)

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER

TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371

306.40262X00 filed August 15, 2001

U.S. APPLICATION NO. (If known, see 37 CFR 1.5

09/913533

INTERNATIONAL APPLICATION NO.

INTERNATIONAL FILING DATE

PRIORITY DATE CLAIMED

PCT/EP00/00274

15 January 2000 (15.01.00)

19 February 1999 (19.02.99)

TITLE OF INVENTION GAS-GENERATING SUBSTANCES

APPLICANT(S) FOR DO/EO/US BLEY, ULRICH; BREDE, UWE; HAGEL, RAINER and REDECKER, KLAUS

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☐ is attached hereto (required only if not communicated by the International Bureau).
 - b. ☒ has been communicated by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
 - a. ☒ is attached hereto.
 - b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
 - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
 - b. ☐ have been communicated by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English lanugage translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment.
14. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
15. ☐ A substitute specification.
16. ☒ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. ☒ Other items or information:

PCT Request Form

International Preliminary Examination Report

International Publication No. WO00/48967

Credit Card Payment Form

U.S. APPLICATION NO. (if known, see 37 CFR 1.53)

INTERNATIONAL APPLICATION NO.

ATTORNEY'S DOCKET NUMBER

09/913533

PCT/EP00/00274

306.40262X00

21. ☒ The following fees are submitted:**BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):**

Neither international preliminary examination fee (37 CFR 1.482)
nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO
and International Search Report not prepared by the EPO or JPO \$1000.00

International preliminary examination fee (37 CFR 1.482) not paid to
USPTO but International Search Report prepared by the EPO or JPO \$860.00

International preliminary examination fee (37 CFR 1.482) not paid to USPTO
but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$710.00

International preliminary examination fee (37 CFR 1.482) paid to USPTO
but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$690.00

International preliminary examination fee (37 CFR 1.482) paid to USPTO
and all claims satisfied provisions of PCT Article 33(1)-(4) \$100.00

ENTER APPROPRIATE BASIC FEE AMOUNT =**CALCULATIONS PTO USE ONLY**

\$ 860.00

Surcharge of \$130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30
months from the earliest claimed priority date (37 CFR 1.492(e)).

\$ 0.00

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	
Total claims	16 -20 =	0	x \$18.00	\$ 0.00
Independent claims	1 -3 =	0	x \$80.00	\$ 0.00

MULTIPLE DEPENDENT CLAIM(S) (if applicable) + \$270.00

\$ 0.00

TOTAL OF ABOVE CALCULATIONS =

\$ 860.00

☐ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above
are reduced by 1/2.

\$ 0.00
+

SUBTOTAL =

\$ 860.00

Processing fee of \$130.00 for furnishing the English translation later than ☐ 20 ☐ 30
months from the earliest claimed priority date (37 CFR 1.492(f)).

\$ 0.00
+

TOTAL NATIONAL FEE =

\$ 860.00

Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be
accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property +

\$ 0.00
+

TOTAL FEES ENCLOSED =

\$ 860.00

Amount to be
refunded:

\$

charged:

\$

- a. ☐ A check in the amount of \$ _____ to cover the above fees is enclosed.
- b. ☐ Please charge my Deposit Account No. _____ in the amount of \$ _____ to cover the above fees.
A duplicate copy of this sheet is enclosed.
- c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any
overpayment to Deposit Account No. 01-2135. A duplicate copy of this sheet is enclosed.
- d. ☒ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card
information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

**NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR
1.137 (a) or (b)) must be filed and granted to restore the application to pending status.**

SEND ALL CORRESPONDENCE TO:

Alan E. Schiavelli
Antonelli, Terry, Stout & Kraus, LLP
1300 North Seventeenth Street
Suite 1800
Arlington, VA 22209

SIGNATURE

Alan E. Schiavelli

NAME

32,087

REGISTRATION NUMBER

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants: BLEY et al

Serial No.:

Filed: August 15, 2001

For: Gas-Generating Substances

Group:

Examiner:

PRELIMINARY AMENDMENT

Assistant Commissioner
for Patents
Washington, D.C. 20231

August 15, 2001

Sir:

Prior to examination on the merits of this application and prior to calculation
of the filing fee, please amend the above-identified application as follows:

IN THE CLAIMS:

Please amend the claims to read as follows:

4. (Amended) Gas-generating substance according to claim 1, characterised in that it additionally contains, in order to control the reactivity of the gases, inert gases, preferably carbon dioxide, air, helium, neon and/or argon.
5. (Amended) Gas-generating substance according to claim 1, characterised in that it contains additions of smell-intensive gases such as e.g. mercaptans in small amounts for detecting leaks.

6. (Amended) Gas-generating substance according to claim 1, characterised in that it contains additions for improving the smell properties of the combustion gases in the when utilisation takes place.
7. (Amended) Gas-generating substance according to claim 1, characterised in that it contains vanillin.
8. (Amended) Gas-generating substance according to claim 1, characterised in that it contains polymers from the group of the hydrocarbons such as ethylene, propylene, isoprene, styrene as fuels.
9. (Amended) Gas-generating substance according to claim 1, characterised in that it contains oxygen-containing fuels which are derived for example from carboxylic acids such as polyvinyl acetates, polymethacrylates, polyterephthalates and/or other polyesters, polyethers, polycarbonates, polyoxymethylenes, oligo- and polysaccharides such as sugar, cellulose, starch, polyvinyl acetals or polyvinyl alcohols.
10. (Amended) Gas-generating substance according to claim 1, characterised in that it also contains explosive substances as additional reactive components of the fuels.
11. (Amended) Gas-generating substance according to claim 1, characterised in that it contains as reactive components one or more compounds from the group nitroguanidine (NiGu) derivatives of tetrazole such as 5-aminotetrazole, 5-aminotetrazole nitrate, bistetrazole amine or bistetrazole, aminoguanidine nitrate, diaminoguanidine nitrate, triaminoguanidine nitrate, guanidine nitrate,

dicyanodiamidine nitrate, diaminoguanidine azotetrazolate, nitrotriazolone,
dicanediamicune nitrate, hexogen, octogen.

12. (Amended) Gas-generating substance according to claim 1, characterised in that it contains as fuel urea, organic acids (e.g. fumaric acid, ascorbic acid, oxalic acid), cork, wood, metals (e. g. aluminium, titanium) and/or non-metals (e.g. boron, silicon), nitrides, azides and/or inorganic benzene (B_3N_3).

13. (Amended) Gas-generating substance according to claim 1, characterised in that the fuels are used in the form of powder, granules, pressings such as e.g. tablets, or in the case of polymers e.g. also as cut fibres or twisted fibres, mats, woven fabrics, porous foams e.g. of polyurethanes.

14. (Amended) Gas-generating substance according to claim 1, characterised in that specific embodiments may be surface-treated by being, for example, impregnated or mixed with liquids or pasty substances, to control the burn-off.

15. (Amended) Gas-generating substance according to claim 1, characterised in that it contains as further additives catalysts, for example ferrocene and derivatives, iron or copper acetylacetonate.

16. (Amended) Gas-generating substance according to claim 1, characterised in that it contains as additions one or more oxidising agents such as nitrates of alkali and alkaline earth elements, perchlorates of alkali and alkaline earth elements, ammonium nitrate, ammonium perchlorate, zinc peroxide, perborates, peroxodisulphates, permanganates, tin dioxide, manganese dioxide, oxidising agents derived from nitramines and mixtures of these components and/or porosity generators, for example

ammonium hydrogencarbonate, acetone dicarboxylic acid, azoiso-butyronitrile and/or hollow plastics spheres.

REMARKS

The foregoing amendments are respectfully requested prior to examination on the merits of this application. A marked up copy of the amended claims is attached.

To the extent necessary, applicants petition for an extension of time under 37 CFR 1.136. Please charge any shortage in the fees due in connection with the filing of this paper, including extension of time fees, to the deposit account of Antonelli, Terry, Stout & Kraus, LLP, Deposit Account No. 01-2135 (Case: 306.40262X00), and please credit any excess fees to such deposit account.

Respectfully submitted,

ANTONELLI, TERRY, STOUT & KRAUS, LLP

A handwritten signature in black ink, appearing to read 'Alan E. Schiavelli', is written over a horizontal line.

Alan E. Schiavelli
Registration No. 32,087

AES/jla
(703) 312-6600

REWRITTEN MARKED UP COPY

4. (Amended) Gas-generating substance according to ~~one or more of claims 1 to 3~~
claim 1, characterised in that it additionally contains, in order to control the reactivity
of the gases, inert gases, preferably carbon dioxide, air, helium, neon and/or argon.
5. (Amended) Gas-generating substance according to ~~one or more of claims 1 to 4~~
claim 1, characterised in that it contains additions of smell-intensive gases such as e.g.
mercaptans in small amounts for detecting leaks.
6. (Amended) Gas-generating substance according to ~~one or more of claims 1 to 5~~
claim 1, characterised in that it contains additions for improving the smell properties
of the combustion gases in the when utilisation takes place.
7. (Amended) Gas-generating substance according to ~~one or more of claims 1 to 6~~
claim 1, characterised in that it contains vanillin.
8. (Amended) Gas-generating substance according to ~~one or more of claims 1 to 7~~
claim 1, characterised in that it contains polymers from the group of the hydrocarbons
such as ethylene, propylene, isoprene, styrene as fuels.
9. (Amended) Gas-generating substance according to ~~one or more of claims 1 to 8~~
claim 1, characterised in that it contains oxygen-containing fuels which are derived
for example from carboxylic acids such as polyvinyl acetates, polymethacrylates,
polyterephthalates and/or other polyesters, polyethers, polycarbonates,
polyoxymethylenes, oligo- and polysaccharides such as sugar, cellulose, starch,
polyvinyl acetals or polyvinyl alcohols.

10. (Amended) Gas-generating substance according to ~~one or more of claims 1 to 9~~ claim 1, characterised in that it also contains explosive substances as additional reactive components of the fuels.

11. (Amended) Gas-generating substance according to ~~one or more of claims 1 to 10~~ claim 1, characterised in that it contains as reactive components one or more compounds from the group nitroguanidine (NiGu) derivatives of tetrazole such as 5-aminotetrazole, 5-aminotetrazole nitrate, bistetrazole amine or bistetrazole, aminoguanidine nitrate, diaminoguanidine nitrate, triaminoguanidine nitrate, guanidine nitrate, dicyanodiamidine nitrate, diaminoguanidine azotetrazolate, nitrotriazolone, dicanediamidine nitrate, hexogen, octogen.

12. (Amended) Gas-generating substance according to ~~one or more of claims 1 to 11~~ claim 1, characterised in that it contains as fuel urea, organic acids (e.g. fumaric acid, ascorbic acid, oxalic acid), cork, wood, metals (e. g. aluminium, titanium) and/or non-metals (e.g. boron, silicon), nitrides, azides and/or inorganic benzene (B₃N₃).

13. (Amended) Gas-generating substance according to ~~one or more of claims 1 to 12~~ claim 1, characterised in that the fuels are used in the form of powder, granules, pressings such as e.g. tablets, or in the case of polymers e.g. also as cut fibres or twisted fibres, mats, woven fabrics, porous foams e.g. of polyurethanes.

14. (Amended) Gas-generating substance according to ~~one or more of claims 1 to 13~~ claim 1, characterised in that specific embodiments may be surface-treated by being, for example, impregnated or mixed with liquids or pasty substances, to control the burn-off.

15. (Amended) Gas-generating substance according to ~~one or more of claims 1 to 14~~ claim 1, characterised in that it contains as further additives catalysts, for example ferrocene and derivatives, iron or copper acetylacetonate.

16. (Amended) Gas-generating substance according to ~~one or more of claims 1 to 15~~ claim 1, characterised in that it contains as additions one or more oxidising agents such as nitrates of alkali and alkaline earth elements, perchlorates of alkali and alkaline earth elements, ammonium nitrate, ammonium perchlorate, zinc peroxide, perborates, peroxodisulphates, permanganates, tin dioxide, manganese dioxide, oxidising agents derived from nitramines and mixtures of these components and/or porosity generators, for example ammonium hydrogencarbonate, acetone dicarboxylic acid, azoiso-butyronitrile and/or hollow plastics spheres.

-1-

GAS-GENERATING SUBSTANCES

5 The invention relates to gas-generating substances, in particular for gas generators in belt tighteners and inflatable air-bags for protecting the occupants of motor vehicles against injuries.

10 With the gas generators currently used for inflatable air-bags, a gas charge in tablet or disc form or as granules or e.g. in noodle form is used as a combustible gas-evolving material. During burn-off, this gas charge generates the useful or compressed gas for the inflation of the air-bag. The disadvantage of the combustion of solid gas-evolving materials is the
15 extremely high amount of slag produced during the combustion, which may make up more than 50% of the gas charge material used. Because of the slag and dust formed during the combustion, complicated filter stages are required in the gas generator in order to retain
20 slag and dust particles. Otherwise the air-bag would be damaged during the discharge of these particles and the occupants may be exposed to danger.

25 As an alternative to these gas charges, generators containing compressed gases or air exist. Very high charging pressures are required for the formation of a sufficient gas volume, since cooling takes place during the outflow of the gases and no increase in volume is achieved through exothermic reactions as in the case of
30 solid mixtures. In order to offset the cooling, a solid propellant fuel is frequently used, which ensures the operation of the gas generator merely through the heat of reaction during its burn-off and the additional gas evolution.

35 The invention is based on the object of providing a

gas-evolving material for a gas generator, in particular for a belt tightener for an inflatable air-bag for protecting the occupant of a motor vehicle against injuries, where slag retention equipment is not required for the gas-evolving material.

The achievement of the aforementioned object consists in a mixture of laughing gas as oxidising agent and one or more fuels that are solid under the usual conditions (room temperature and standard pressure). Used as a gas-evolving material is laughing gas (N_2O) as oxidising agent in combination with solid fuels or mixtures which react after ignition in a controlled manner in the combustion chamber to form slag-free or largely slag-free gaseous reaction products. The pressurised laughing gas is ignited together with the solid fuels by an ignition device containing an ignition charge. Use may be made as an ignition charge, for example, of an exploding wire or an ignition bridge, optionally with reinforcement with a booster charge, to produce a particle-rich, hot flame.

The ignition fumes and hot combustion gases ignite the gas/solid mixture. The latter burns in the combustion chamber without solid particles remaining. Filter stages that are positioned before at least one outlet opening of the gas generator housing wall may therefore be dispensed with when the gas/solid mixture according to the invention is used. If filter stages are provided, the latter serve exclusively cooling purposes. The cooling may also be carried out in another manner, however, by, for example, fitting downstream of the combustion chamber a distribution compartment of the housing, from which the combustion gases pass to the outside via at least one outlet opening.

According to the invention gases or gas mixtures with low intake pressure are proposed, which, as a result of exothermic conditions, produce a manifold increase in volume on burn-off and require no filters of any kind.

5 The gas or gas mixture usable according to the invention consists of the oxidising agent. In order to avoid high intake pressures, oxygen or air is dispensed with as oxidising agent. In dinitrogen monoxide (laughing gas) there exists a gas which may be easily
10 liquefied (critical pressure: 72.7 bar, critical temperature: 36.4 °C). The oxidising capacity is twice as high as that of air and in contrast to pure oxygen or air, laughing gas behaves up to at least 200 °C as an inert gas, as a result of which quiescent oxidising
15 processes are prevented even during storage at high temperature. Nitrogen monoxide (NO/N₂O, critical pressure 64 bar, critical temperature - 93 °C) may also be used in a mixture with laughing gas or as a gaseous oxidising agent on its own. In order to control the
20 reactivity of the gases, inert gases (carbon dioxide, air, helium, neon, argon) may be added. The use of nitrogen monoxide has the advantage that there is no formation of condensed portions which first have to evaporate during the burn-off reaction. Additions of
25 smell-intensive gases such as e.g. mercaptans in small amounts may make a rapid detection of leaks possible. The addition of e.g. vanillin improves the smell properties of the burn-off fumes in the application case.

30 According to the invention, used as fuels are polymers from the group of the hydrocarbons, such as ethylene, propylene, isoprene, styrene, as well as those which may also contain oxygen and are derived from e.g.
35 carboxylic acids such as polyvinyl acetates, polymethacrylates, polyterephthalates and other

polyesters, polyethers, polycarbonates, and also
polyoxymethylene, oligo- and polysaccharides such as
sugar, cellulose, starch, polyvinyl acetals or
polyvinyl alcohols. In addition, however, further
5 polymers of different compositions are also usable,
provided the reaction products do not contain any
dangerous components in an inadmissible amount, such as
e.g. HCl, HCN, HF or phosgene. Explosive substances may
also be used as additional reactive components of the
10 fuels. Examples are nitroguanidine (NiGu), derivatives
of tetrazole such as 5-aminotetrazole, 5-aminotetrazole
nitrate, bistetrazole amine or bistetrazole,
aminoguanidine nitrate, diaminoguanidine nitrate,
triaminoguanidine nitrate, guanidine nitrate,
15 dicyanodiamidine nitrate, diaminoguanidine
azotetrazolate, nitrotriazolone, dicanediamidine
nitrate, hexogen, octogen. The following may be used,
for example, as further fuels: urea, organic acids
(e.g. fumaric acid, ascorbic acid, oxalic acid), cork,
20 wood, metals (e.g. aluminium, titanium) and non-metals
(e.g. boron, silicon), nitrides, azides or inorganic
benzene (B_3N_3). The fuels may be applied in the form of
powder, granules, pressings such as e.g. tablets, or in
the case of polymers e.g. also as cut fibres or twisted
25 fibres, mats, woven fabrics, porous foams e.g. of
polyurethanes. To control the burn-off, the specific
embodiments may be surface-treated by being impregnated
or mixed with liquids or pasty substances (inhibitors).

30 Further additives catalysts may be used, for example
ferrocene and derivatives, iron or copper
acetylacetonate and/or oxidising agents such as, for
example, nitrates of alkali and alkaline earth
elements, perchlorates of alkali and alkaline earth
35 elements, ammonium nitrate, ammonium perchlorate, zinc
peroxide, perborates, peroxodisulphates, permanganates,

tin dioxide, manganese dioxide, oxidising agents derived from the nitramines and mixtures of these components and/or porosity generators, such as for example ammonium hydrogencarbonate, acetone dicarboxylic acid, azoisobutyronitrile and/or hollow plastics spheres.

The ratio by weight of the fuels to dinitrogen monoxide is preferably adjusted in such a way that a non-combustible gas mixture is obtained after the reaction. Accordingly the ratio by weight of the fuels to dinitrogen monoxide should be adapted to the stoichiometric proportions of a (where possible) complete combustion. Dinitrogen monoxide is therefore used to advantage in a slight excess, referred to the fuel. The reaction products then consist substantially of gaseous substances (CO_2 , H_2O and N_2). The gas/solid systems described according to the invention produce, according to how they are chosen, residue-free, almost CO - and NO_x -free, reaction products, with the burn-off property being controllable according to the nature, proportion by weight, geometry and configuration of the fuel.

The invention will be described in detail below through examples, without however limiting it:

Examples:

All the tests are carried out in a sealed pressure vessel with a volume of approx. 120 ml. The ignition is performed electrically with 150 mg of a boron/potassium nitrate mixture as booster. The laughing gas is fed into the vessel by means of a compressor. The weighed portion of laughing gas may be determined by weighing of the vessel before and after

the charging. The internal pressure in the vessel comes after the feeding to approx. 4 Mpa. The solid selected is weighed into the vessel prior to the charging with laughing gas. The pressure measurement is carried out in the vessel by piezoelectric pressure elements.

Maximum pressure (p_{max}), pressure increase time (Δt) and time until maximum pressure (t_{pmax}) is reached are measured. In Example 1 the behaviour of the laughing gas without additional fuel is shown (see Table 1).

Heating and pressure increase takes place in the vessel due to the ignition, which pressure increase however differs significantly from the burn-off behaviour in the presence of solids, as Examples 2 - 4 show. In Examples 2 - 4 the burn-off behaviour of various materials such as polystyrene, nitroguanidine and starch is represented. A summary of the results is given in Table 1.

091353 121001

Table 1: Summary of results of Examples 1 - 4

Example	Solid	Weighed portion solid [g]	Weighed portion laughing gas [g]	p_{max} [Mpa]	Δt [ms]	t_{pmax} [Mpa]
1	-	-	11	42	11.2	15.4
2	P o l y - styrene	1.1	11	62	2.2	7.1
3	Nitroguani dine	1.1	11	69	1.1	4.4
4	Starch (flour)	1.1	11	64	4.2	11.5

In Examples 5 - 9 the influence of various make-ups and geometries of the solid on the burn-off characteristics in the pressure vessel is shown. Two solids are used, first of all starch in various modifications, here characterised by the particle diameter, and secondly nitroguanidine as a loose powder with a grain size of approx. 50 μm and as tablet with a diameter of 7 mm and a depth of approx. 2.3 mm. A summary of results is given in Table 2.

Table 2: Summary of results of Examples 5 - 9

Example	Solid	Geometry	p_{\max} [Mpa]	Δt [ms]	$t_{p\max}$ [Mpa]
5	Starch	Sphere D: 1 - 2 μm	63.7	4.2	11.6
6	Starch	Sphere D: approx. 250 μm	66.4	7.01	21.9
7	Starch	Sphere D: approx. 1 mm	61.7	9.4	29.9
8	Nitroguani- dine	P o w d e r grain size approx. 50 μm	68.6	1.1	4.4
9	Nitroguani- dine	Tablet D 7 mm, D 2.3 mm	60.1	10.7	38.5

Very good estimates of gas composition and combustion temperatures are obtained by means of thermodynamic calculations. In Examples 10 - 12 a thermodynamic calculation is carried out with the ICT code for polystyrene, nitroguanidine and starch. It is based in each case on a solid-lauging gas mixture of 9 to 91 wt %. A summary of the results is given in Table 3.

Table 3: Summary of results of Examples 10 - 12

Example	Combustion temperature [K]	N ₂ [vol. %]	CO ₂ [vol. %]	H ₂ O [vol. %]	O ₂ [vol. %]	CO [vol. %]	NO _x [vol. %]
10	4075	63.1	21.2	10.4	5.2	< 0.001	0.06
11	2710	64.9	2.4	5.0	27.5	< 0.001	0.14
12	3181	61.2	9.8	8.2	20.6	< 0.001	0.11

Downloaded from ascelibrary.org by Seattle University on 06/01/16

Claims

1. Gas-generating substance, characterised in that
it consists of a mixture of laughing gas and one
5 or more fuels which are solid at room temperature
and standard pressure.
2. Gas-generating substance, characterised in that
it consists of a mixture of nitrogen monoxide and
10 one or more fuels which are solid at room
temperature and standard pressure.
3. Gas-generating substance, characterised in that
it consists of a mixture of laughing gas with
15 nitrogen monoxide and one or more fuels which are
solid at room temperature and standard pressure.
4. Gas-generating substance according to one or more
of claims 1 to 3, characterised in that it
20 additionally contains, in order to control the
reactivity of the gases, inert gases, preferably
carbon dioxide, air, helium, neon and/or argon.
5. Gas-generating substance according to one or more
25 of claims 1 to 4, characterised in that it
contains additions of smell-intensive gases such
as e.g. mercaptans in small amounts for detecting
leaks.
- 30 6. Gas-generating substance according to one or more
of claims 1 to 5, characterised in that it
contains additions for improving the smell
properties of the combustion gases in the when
35 utilisation takes place.
7. Gas-generating substance according to one or more

of claims 1 to 6, characterised in that it contains vanillin.

- 5 8. Gas-generating substance according to one or more of claims 1 to 7, characterised in that it contains polymers from the group of the hydrocarbons such as ethylene, propylene, isoprene, styrene as fuels.
- 10 9. Gas-generating substance according to one or more of claims 1 to 8, characterised in that it contains oxygen-containing fuels which are derived for example from carboxylic acids such as polyvinyl acetates, polymethacrylates, 15 polyterephthalates and/or other polyesters, polyethers, polycarbonates, polyoxymethylenes, oligo- and polysaccharides such as sugar, cellulose, starch, polyvinyl acetals or polyvinyl alcohols.
- 20 10. Gas-generating substance according to one or more of claims 1 to 9, characterised in that it also contains explosive substances as additional reactive components of the fuels.
- 25 11. Gas-generating substance according to one or more of claims 1 to 10, characterised in that it contains as reactive components one or more compounds from the group nitroguanidine (NiGu), 30 derivatives of tetrazole such as 5-aminotetrazole, 5-aminotetrazole nitrate, bistetrazole amine or bistetrazole, aminoguanidine nitrate, diaminoguanidine nitrate, triaminoguanidine nitrate, guanidine nitrate, 35 dicyanodiamidine nitrate, diaminoguanidine azotetrazolate, nitrotriazolone, dicanediamidine

FOOT 665666

nitrate, hexogen, octogen.

- 5 12. Gas-generating substance according to one or more
of claims 1 to 11, characterised in that it
contains as fuel urea, organic acids (e.g.
fumaric acid, ascorbic acid, oxalic acid), cork,
wood, metals (e.g. aluminium, titanium) and/or
non-metals (e.g. boron, silicon), nitrides,
azides and/or inorganic benzene (B_3N_3).
- 10 13. Gas-generating substance according to one or more
of claims 1 to 12, characterised in that the
fuels are used in the form of powder, granules,
pressings such as e.g. tablets, or in the case of
15 polymers e.g. also as cut fibres or twisted
fibres, mats, woven fabrics, porous foams e.g. of
polyurethanes.
- 20 14. Gas-generating substance according to one or more
of claims 1 to 13, characterised in that specific
embodiments may be surface-treated by being, for
example, impregnated or mixed with liquids or
pasty substances, to control the burn-off.
- 25 15. Gas-generating substance according to one or more
of claims 1 to 14, characterised in that it
contains as further additives catalysts, for
example ferrocene and derivatives, iron or copper
acetylacetonate.
- 30 16. Gas-generating substance according to one or more
of claims 1 to 15, characterised in that it
contains as additions one or more oxidising
agents such as nitrates of alkali and alkaline
35 earth elements, perchlorates of alkali and
alkaline earth elements, ammonium nitrate,

0913533-421001

5 ammonium perchlorate, zinc peroxide, perborates, peroxodisulphates, permanganates, tin dioxide, manganese dioxide, oxidising agents derived from nitramines and mixtures of these components and/or porosity generators, for example ammonium hydrogencarbonate, acetone dicarboxylic acid, azoiso-butyronitrile and/or hollow plastics spheres.

09913533 121001



Attorney's Docket No.: 306.40262X00

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that: my residence, post office address and country of citizenship are as stated below, next to my name; I believe I am the original, first, and sole inventor (if only one name is listed below) or an original, first, and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

GAS-GENERATING SUBSTANCES

the specification of which

is attached hereto.

Xwas filed on February 15, 2000 asUnited States Application Number 09/913,533or PCT International Application Number PCT/EP00/00274

and was amended on _____

(if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claim(s), as amended by any amendment referred to above. I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d), of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)Priority
Claimed

<u>199 07 241.8</u> (Number)	<u>Germany</u> (Country)	<u>19/2/99</u> (Day/Month/Year Filed)	Yes	No
_____ (Number)	_____ (Country)	_____ (Day/Month/Year Filed)	_____ Yes	_____ No

I hereby claim the benefit under title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below

(Application Number)_____
Filing Date_____
(Application Number)_____
Filing Date

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, Section 112, I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

09913533 121001

Title 37, Code of Federal Regulations, Section 1.56
Duty to Disclose Information Material to Patentability

(a) A patent by its very nature is affected with a public interest. The public interest is best served, and the most effective patent examination occurs when, at the time an application is being examined, the Office is aware of and evaluates the teachings of all information material to patentability. Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability as defined in this section. The duty to disclose information exists with respect to each pending claim until the claim is cancelled or withdrawn from consideration, or the application becomes abandoned. Information material to the patentability of a claim that is cancelled or withdrawn from consideration need not be submitted if the information is not material to the patentability of any claim remaining under consideration in the application. There is no duty to submit information which is not material to the patentability of any existing claim. The duty to disclose all information known to be material to patentability is deemed to be satisfied if all information known to be material to patentability of any claim issued in a patent was cited by the Office or submitted to the Office in the manner prescribed by §§ 1.97(b)-(d) and 1.98. However, no patent will be granted on an application in connection with which fraud on the Office was practiced or attempted or the duty of disclosure was violated through bad faith or intentional misconduct. The Office encourages applicants to carefully examine:

- (1) Prior art cited in search reports of a foreign patent office in a counterpart application, and
- (2) The closest information over which individuals associated with the filing or prosecution of a patent application believe any pending claim patentably defines, to make sure that any material information contained therein is disclosed to the Office.

(b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made of record in the application, and

- (1) It establishes, by itself or in combination with other information, a prima facie case of unpatentability of a claim;
- or
- (2) It refutes, or is inconsistent with, a position the applicant takes in:
 - (i) Opposing an argument of unpatentability relied on by the Office, or
 - (ii) Asserting an argument of patentability.

A prima facie case of unpatentability is established when the information compels a conclusion that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability.

(c) Individuals associated with the filing or prosecution of a patent application within the meaning of this section are:

- (1) Each inventor named in the application;
 - (2) Each attorney or agent who prepares or prosecutes the application; and
 - (3) Every other person who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, with the assignee or with anyone to whom there is an obligation to assign the application.
- (d) Individuals other than the attorney, agent or inventor may comply with this section by disclosing information to the attorney, agent, or inventor.

09913533 "121001"

(Application Number)

Filing Date

(Status -- patented,
pending, abandoned)

(Application Number)

Filing Date

(Status -- patented,
pending, abandoned)

I hereby appoint: Donald R. Antonelli, Reg. No. 20,296; Melvin Kraus, Reg. No. 22,466; William I. Solomon, Reg. No. 28,565; Gregory E. Montone, Reg. No. 28,141; Ronald J. Shore, Reg. No. 28,577; Donald E. Stout, Reg. No. 26,422; Alan E. Schiavelli, Reg. No. 32,087; James N. Dresser, Reg. No. 22,973; Carl I. Brundidge, Reg. No. 29,621; Paul J. Skwierawski, Reg. No. 32,173; and Robert M. Bauer, Reg. No. 34,487, my attorneys; of ANTONELLI, TERRY, STOUT & KRAUS, LLP with offices located at 1300 North Seventeenth Street, Suite 1800, Arlington, Virginia 22209, telephone: (703) 312-6600, fax: (703) 312-6666; with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected herewith.

Send all correspondence to:

Customer Number 020457
ANTONELLI, TERRY, STOUT & KRAUS, LLP
1300 North Seventeenth Street
Suite 1800
Arlington, VA. 22209

Direct all telephone calls and faxes to:

TEL: (703) 312-6600
FAX: (703) 312-6666

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full Name of Sole/First Inventor Ulrich BLEYInventor's Signature *Ulrich Bley*Date 12.12.01Residence Same as P.O. Box Address

Citizenship _____

(City, State)

(Country)

Post Office Address Kleinreuther Weg 42, D-90408, Nürnberg, Germany DEXFull Name of Second/Joint Inventor Uwe BREDEInventor's Signature *Uwe Bredt*Date 9. Nov. 2001Residence Same as P.O. Box Address

Citizenship _____

(City, State)

(Country)

Post Office Address Boenerstrasse 32, D-90765, Fürth, Germany DEX

Full Name of Third/Joint Inventor Rainer HAGELInventor's Signature Rainer Hagel Date 21. Nov. 2001Residence Same as P.O. Box Address Citizenship _____
(City, State) (Country)Post Office Address Schorlachstrasse 23, D-91058, Erlangen, Germany DEXFull Name of Fourth/Joint Inventor Klaus REDECKERInventor's Signature Klaus Redeker Date 09. NOV. 01Residence Same as P.O. Box Address Citizenship _____
(City, State) (Country)Post Office Address Burgfarnbacher Strasse 34, D-90431, Nürnberg DEX

Full Name of Fifth/Joint Inventor _____

Inventor's Signature _____ Date _____

Residence _____ Citizenship _____
(City, State) (Country)

Post Office Address _____

Full Name of Sixth/Joint Inventor _____

Inventor's Signature _____ Date _____

Residence _____ Citizenship _____
(City, State) (Country)

Post Office Address _____

Full Name of Seventh/Joint Inventor _____

Inventor's Signature _____ Date _____

Residence _____ Citizenship _____
(City, State) (Country)

Post Office Address _____

00013533 "1001"

09/13533
5 AUG 2001**CHANGE OF
CORRESPONDENCE ADDRESS**
Application

Application Number

518 Rec'd PCT/PTO

Filing Date

August 15, 2001

First Named Inventor

BLEY, Et al

Group Art Unit

Examiner Name

Attorney Docket Number

306.40262X00

Address to:

Assistant Commissioner for Patents
Washington, D.C. 20231

Please change the Correspondence Address for the above-identified application to:



Customer Number

020457

Type Customer Number here



020457

PATENT TRADEMARK OFFICE

OR

☐ Firm or
Individual Name

Address

Address

City

State

ZIP

Country

Telephone

Fax

This form cannot be used to change the data associated with a Customer Number. To change the data associated with an existing Customer Number use "Request for Customer Number Data Change" (PTO/SB/124).

I am the :



Applicant.

Assignee of record of the entire interest.
Certificate under 37 CFR 3.73(b) is enclosed.

Attorney or agent of record.

Typed or
Printed Name

Alan E. Schiavelli

Registration NO.

32,087

Signature

Date

August 15, 2001